FuelCell Energy

cal state, northridge

Fuel Cell Power Plant and Combined Heat and Power Facility

California State University, Northridge (CSUN) has established itself as one of the nation's leading academic institutions in taking action to reduce global warming. Students throughout the California State University (CSU) system have provided significant support for clean energy technology initiatives. After two years of urging by students, the CSU Board of Trustees unanimously enacted one of the most comprehensive university policies on clean energy in the United States.

Sustainability Context

In 2006, CSUN sought to install an ultra-clean fuel cell power plant — within a combined heat and power application — to help the University meet its goals for greater energy independence, cost management and increased use of green power.

Fuel cells are among the cleanest, most reliable sources of power generation today. They provide continuous high-quality power 24 hours a day, with ultra-low emissions and quiet operation. Their heat byproduct can be employed in combined heat and power (CHP) applications that use hot water, steam or chilled water to heat and cool buildings. Moreover, fuel cell power plants lower the demand for power from local utilities, further limiting the greenhouse gas emissions that would have been produced by generating the electricity at conventional power plants.

Integrated Infrastructure

A high-efficiency Direct FuelCell® (DFC®) power plant generates base load electricity for the University's facilities and provides surplus heat for hot water. It is connected to and operates in parallel with the campus' high voltage infrastructure and the local utility grid. With a continuous output of 1,000 kilowatts of power and a rated electrical efficiency of 47 percent, the fuel cell has a 25-year life, with routine maintenance and regular stack replacements.

Thermal energy recovered from the fuel cell's exhaust supplements the system that heats neighboring campus buildings, including the Student Union conference and recreation facilities, and provides heating for the student pool and domestic hot water. This combined heat and power application (fuel cell and thermal recovery) raises overall electrical efficiency by up to 80 percent.

cal state, northridge

"Having a state-of-the-art fuel cell plant right here on campus is a unique research opportunity for mechanical and electrical engineering faculty, and an extraordinary opportunity for us to mentor our student engineers. My current research is studying the performance of the system used to recover thermal energy in the fuel cell exhaust streams. Calculations indicate that the Combined Heat and Power efficiency of this plant should exceed 80 percent."

– Dr. Robert Ryan, CSUN's College of Engineering & Computer Science

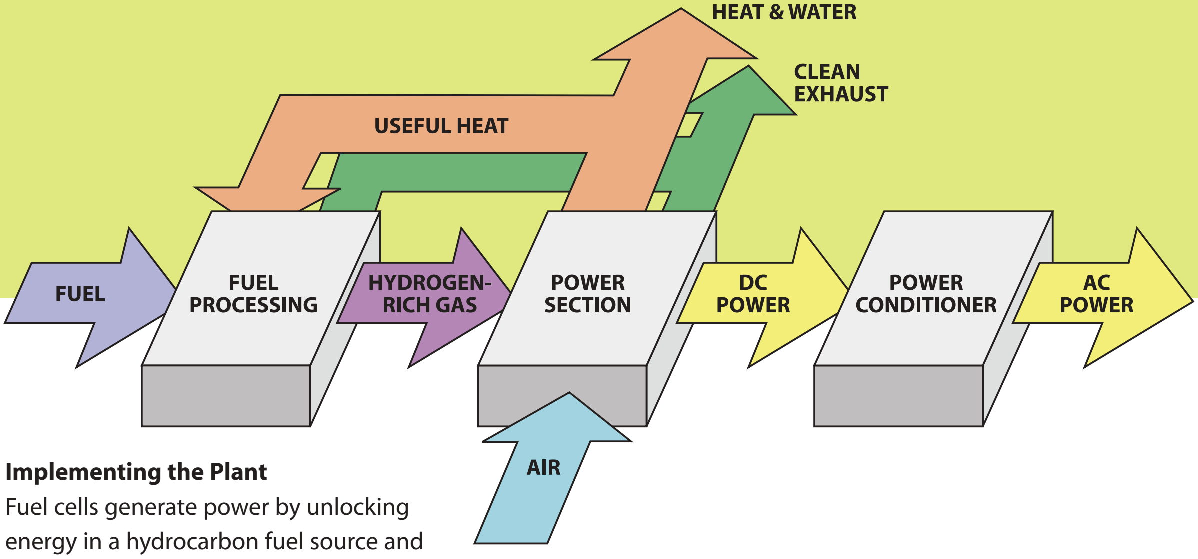
Exhaust from the power plant's heat exchanger is designed to flow into an adjacent greenhouse, where research on CO2 plant enrichment takes place. CO2 enrichment has been found to enhance photosynthesis, boosting plant growth and harvests by 10-40 percent and is only now beginning to be used commercially for growing produce. Eventually, the University also will route exhaust into a specially developed subtropical miniature rainforest, a unique facility enabling a range of biological studies and completing a sustainability loop with the power plant's systems.

Results

The project provides exceptional overall value by reducing the University's electricity costs while balancing environmental impact and expenses. Of equal import, the plant provides real-world research opportunities for campus faculty and students.

As CSUN dedicates the power plant, it emerges as the single largest fuel cell at any university in the world — and only the seventh DFC unit of any size installed at an institution of higher education. The facility:

- Generates approximately 8,333,000 kilowatt hours of electricity annually, or approximately 18 percent of the campus' base-load power requirements.
- Produces 22 billion British Thermal Units (BTUs) of thermal energy per year in the form of usable hot water, enough energy to heat and cool 45 large homes in a harsh climate for an entire year.
- Rates a combined heat and power efficiency of 83 percent, meaning that proportion of the energy stored in its fuel is captured and recovered -- either as electricity or usable thermal energy. The U.S. electrical grid today has an efficiency of under 40 percent.
- Produces virtually no NOx, CO, SOx, volatile organic compounds or particulate emissions. While the average U.S. fossil fuel power plant produces nearly 25 pounds of these emissions per megawatt hour, the DFC fuel cell produces just 0.1 pounds of these emissions. Over the course of one year's operations, operation of this facility results in a reduction of over 100 tons of harmful emissions.
- Reduces greenhouse gas emissions by 69 percent compared to the same amount of energy being generated by California's electrical grid portfolio of hydro, coal, natural gas, nuclear and renewables. Due to its efficiency, the facility eliminates the emission of more than 6,400 tons of CO2 into the environment per megawatt year.



Implementing the Plant

Fuel cells generate power by unlocking energy in a hydrocarbon fuel source and turning it into usable heat, water and electricity. The process is electrochemical, involving no combustion. Since nothing is burned, the process is inherently cleaner than fossil fuel plants, so it creates electricity with up to twice the efficiency of those traditional plants. Direct FuelCell power plants can run on any hydrocarbon fuel, including renewables (like ethanol, or gas created in treating wastewater), as well as readily available fuels such as natural gas or propane. The power plant itself consists of two basic segments: a fuel cell stack module that converts fuel into Direct Current (DC) electricity, and the balance of plant (BOP). The BOP handles fuel going into the plant; on the output side, it also converts the electrical energy from DC to Alternating Current (AC) so it may be interconnected with a customer's electrical distribution system.

Alliance Power provided the high-temperature fuel cells from FuelCell Energy, and supported the design and construction team with expert technical consulting services during the project. P2S was commissioned as the engineer of record, and developed the civil, mechanical and electrical design for the facility. Digital Energy produced initial studies and technical evaluations prior to project award, and coordinated all startup and commissioning activities. CSUN Physical Plant Management provided overall project management, procured the balance of plant materials and equipment, and performed all construction activities, using both staff and students. FuelCell Energy manufactured the DFC units and provides operations and maintenance services.

Careful planning and management of utility interconnection applications and construction targets allowed the project to meet the requirements of the California Self-Generation Incentive Program (SGIP) and other financial incentive requirements of the Los Angeles Department of Water and Power (LADWP). All work was completed well within a one-year time frame, from conceptual design to a fully operational cogeneration facility. Site work included demolition and site preparation, installation of concrete equipment pads, underground piping for natural gas and water, and a 480-volt electrical service. CSUN managed all of the project activities associated with obtaining funding through Southern California Gas Company's SGIP and LADWP, including completing all applications and working closely with their staffs. Although operations and maintenance activities for the DFC units are performed by FuelCell Energy, on-site training for CSUN personnel also was provided during the plant's commissioning.

The fuel cell's performance is continuously observed through FuelCell Energy's web-based control and monitoring system. Fuel cell inputs and outputs and balance of plant equipment are monitored by a custom Supervisory Control and Data Acquisition (SCADA) system that is integrated with CSUN's operations center and networked with the campus' Siemens Energy Management System. The monitoring system provides Physical Plant Management staff immediate access to pertinent cogeneration system information including electricity production, waste heat recovery and fuel consumption.

FuelCell Energy integrated all of the fuel cell components within the power plant. CSUN ensured that all utility interconnection points were integrated with the fuel cell and the rest of the Physical Plant infrastructure. Alliance Power provided expert consultation services from inception to final completion. In addition to the fuel cell equipment, CSUN contracted for electrical interconnection equipment, and designed and constructed its own hot water heat recovery equipment which captures the fuel cell's exhaust heat byproduct.

For More Information

California State University, Northridge
Physical Plant Management
Tom Brown
(818) 677-2325
tom.brown@csun.edu
www.csun.edu

FuelCell Energy, Inc.
William Karambelas
Phone: 949-305-4595
karambelas@fce.com
www.fuelcellenergy.com

Alliance Power
Brian Moreau
(303) 730-2328
brian-moreau@alliancepower.com
www.alliancepower.com

Project Facts

Four DFC300MA™ fuel cell power plants combine to produce a total of 1 megawatt of base-load power in parallel with the utility grid

Construction initiated: April 2006

Startup completed: January 2007

Facility dedicated: February 2007

Total project cost: $ 5,260,000

Total funding incentives: $ 2,750,000

Annual net energy cost savings (electric + thermal): $ 235,000

Annual campus maintenance cost savings (with satellite chiller plant): $ 65,000

Est. capital growth project savings over 25 years (with satellite chiller plant): $ 7,000,000

Net combined savings projected over 25 years: $ 14,500,000

Fuel Cell Energy, Inc.
3 Great Pasture Road
Danbury, CT 06813-1305
203.825.6000

www.fuelcellenergy.com